PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
FP1865		
International application No.	International filing date (*day/month/year*)	Priority Date (*day/month/year*)
PCT/SG 2003/000043	27 February 2003 (27.02.2003)	
International Patent Classification (IPC) or national classification and IPC		
IPC[7]: G06T 7/60		
Applicant		
AGENCY FOR SCIENCE, TECHNOLOGY AND RESEARCH		

1. This international preliminary examination report has been prepared by this International Preliminary Examination Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 4 sheets, including this cover sheet.

☒ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 2 sheets.

3. This report contains indications relating to the following items:

- I. ☒ Basis of the opinion
- II. ☐ Priority
- III. ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV. ☐ Lack of unity of invention
- V. ☒ Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI. ☐ Certain documents cited
- VII. ☐ Certain defects in the international application
- VIII. ☐ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
20.08.2004	9 March 2005 (09.03.2005)
Name and mailing address of the IPEA/AT Austrian Patent Office Dresdner Straße 87 A-1200 Vienna Facsimile No. 1/53424/200	Authorized officer KOVACS G. Telephone No. 1/53424/575

Form PCT/IPEA/409 (cover sheet) (July 1998)

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International application No.
PCT/SG 2003/000043

I. Basis of the report

1. With regard to the elements of the international application:*

☐ the international application as originally filed

☒ the description:
pages 1-17, 19-25, as originally filed
pages 18, filed with the demand
pages _____, filed with the letter of _____.

☒ the claims:
pages 26-30, 32-33, as originally filed
pages _____, as amended (together with any statement) under Article 19
pages 31, filed with the demand
pages _____, filed with the letter of _____.

☒ the drawings:
pages 1-11, as originally filed
pages _____, filed with the demand
pages _____, filed with the letter of _____.

☐ the sequence listing part of the description:
pages _____, as originally filed
pages _____, filed with the demand
pages _____, filed with the letter of _____.

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.
These elements were available or furnished to this Authority in the following language _____ which is:

☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).

☐ the language of publication of the international application (under Rule 48.3(b)).

☐ the language of the translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

☐ contained in the international application in printed form.

☐ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority in written form.

☐ furnished subsequently to this Authority in computer readable form.

☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. ☐ The amendments have resulted in the cancellation of:

☐ the description, pages _____.

☐ the claims, Nos. _____.

☐ the drawings, sheets/fig _____.

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).**

** Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).*

*** Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.*

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V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement			
Novelty (N)	Claims	1-53	YES
	Claims	----	NO
Inventive step (IS)	Claims	1-53	YES
	Claims	----	NO
Industrial applicability (IA)	Claims	1-53	YES
	Claims	----	NO

Citations and explanations (Rule 70.7)

The following documents have been cited in the Search Report:

D1: LUNDERVOLD, A. et al. Segmentation of Brain Parenchyma and Cerrebrospinal Fluid in Multispectral Magnetic Resonance Images.
Medical Imaging, IEEE Transactions,
June 1995, Vol.14, Issue: 2, pages 339-349, ISSN 0278-0062.

D2: SCHNACK, H.G. et al. Automatic Segmentation of the Venticular System from MR Images of the Human Brain.
NeuroImage 2001,
May 2001, Vol.14, pages 95-104

D3: US5262945A

Document D1, which is considered to represent together with documents D2 and D3 the closest prior art, discloses a method to segment brain parenchyma and cerebrospinal fluid spaces automatically in routine axial spin echo multispectral MR images. The algorithm simultaneously incorporates information about anatomical boundaries and tissue signature using a priori knowledge. The head and brain are divided into four regions and seven different tissue types. Each tissue type is modelled by a multivariate Gaussian distribution. Each region is associated with a finite mixture density corresponding to its constituent tissue types. Initial estimates of tissue parameters are obtained from k-means clustering of a single slice used for training. The first algorithmic step uses the EM-algorithm for adjusting the initial tissue parameter estimates to the MR data of new patients. The second step uses a recently developed model of dynamic contours to detect three simply closed nonintersecting curves in the plane, constituting the arachnoid/dura mater boundary of the brain, the border between the suprachnoid space and brain parenchyma, and the inner border of the parenchyma toward the lateral ventricles. The model, which is formulated by energy functions in a Bayesian framework, incorporates a priori knowledge, smoothness constraints, and updated tissue type

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Supplemental Box
(To be used when the space in any of the preceding boxes is not sufficient)

Continuation of: Box V (page 1)

parameters.
According to the disclosure of document D2, an algorithm is described that automatically segments the lateral and third ventricles from T1-weighted 3-D-FFE MR images of the human brain. The algorithm is based upon region-growing and mathematical morphology operators and starts from a coarse binary total brain segmentation, which is obtained from the 3-D-FFE image. Anatomical knowledge of the ventricular system has been incorporated into the method in order to find all constituting parts of the system, even if they are disconnected, and to avoid inclusion of nonventricle cerebrospinal fluid regions.

Document D3 discloses a simple, rapid and semi-automated method of MRI analysis based on mathematical modelling of MRI pixel intensity histograms. The method can be used to reveal significant age-related changes in regional brain volumes which cannot be determined utilising traced central CSF volumes or subarachnoid CSF volumes. The method can be used to quantify brain structure in healthy aging and brain disease.

Though each of the cited documents D1 to D3 addresses the subject matter of independent claim 1 inasmuch as they disclose several features, the cited documents do not show the entire set of claimed features. Consequently, the subject matter of independent claim 1 is new and inventive as well.

By virtue of dependency, the subject matter of dependent claims 2 to 53 is new and involves an inventive step as well.

In conclusion, documents D1 to D3 represent the general state of the art, which has not the potential to raise doubt on novelty and inventiveness of the subject matter of all claims 1 to 53 of the present application.

Industrial applicability is given.

The corrected version of pages 18 and 31 is acceptable under Rule 91.1(e)(iii).

2. Calculate a profile along each sample line segment (to increase the robustness, several lines, 3 for example, can be used to obtain the averaged profile as in 2.4.1 above).

3. Calculate the length of the CSF in each averaged profile and compare the length to the previous one. When this length starts decreasing for at least two subsequent line segments, take, for example, the middle of the longest CSF segment as the seed point.

2.5 Grow each ventricular region

The ventricular regions are grown in 3D independently starting from the defined seed points (Step 3.3, Figure 1). Region growing is directional which allows for better control of growing in 3D space.

Let m be the minimum, M the maximum and μ the mean values of the CSF range calculated in Step 3.1. By using the complete range of intensities [m, M], the region grown may be overestimated because of the partial volume effect. Let s be a scaling factor between 0 and 1. Region growing can then be better controlled by using the following growing range $[\mu - s*(\mu - m), \mu + s*(M - \mu)]$ with a variable value of s. For s = 0, only the mean value of CSF is used for growing. For s = 1, the full range of CSF is utilized. For s = 0, the region grown may be underestimated while for s=1 it may be overestimated. The value of s has to be selected based on quantitative assessment.

To facilitate region growing, the ventricular regions are further subdivided into smaller subregions, as illustrated in FIGs. 9a and 9b. This approach has several advantages, namely:

- Region growing is simplified as complex shapes are replaced by simpler ones.
- Easier control regarding growing and connecting.
- Better leakage control, as it is easier to incorporate specific domain knowledge in each subregion.
- Processing is more efficient as only a subregion needs to be regrown in case of leakage.
- Facilitated reduction of the partial volume effect, as it is easier to incorporate specific domain knowledge in each subregion.
- Easier to adjust the initial thresholds tailored to the local anatomy.

2.5.1 Growing of VLL-B and VLR-B

Each of the VLL-B and the VLR-B regions is grown in 3D space on coronal slices, slice by slice. Growing is initiated anteriorly from the seed point located on the VAC. When this growing is completed, it is continued posteriorly on all subsequent coronal slices. Eventually, it is continued anteriorly when attempting to extract the posterior part of the inferior horn.